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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
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ART UNIT	PAPER NUMBER
2826	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/797,224	WU ET AL.	
	Examiner	Art Unit	
	Ben P. Sandvik	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 July 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-6,8-16 and 18-52* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *48-52* is/are allowed.

6)☒ Claim(s) *1,2,4-6,8-16,18-40 and 42-47* is/are rejected.

7)☒ Claim(s) *8-13,41 and 45* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

Applicant's arguments with respect to claim 1 have been considered but are moot in view of the new ground(s) of rejection.

Claim Objections

Claims 8-13 objected to because of the following informalities: they depend from claim 7, which has been cancelled. Appropriate correction is required.

Claim 45 objected to because of the following informalities: the inequality intended to be in the space between S1 and S2 has been omitted. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 6, 7, 11, 13-15, 20, 21, 26, 28, 29, 33, 34, 38, and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao et al (U.S. Patent #6455417), in view of Andideh et al (U.S. Patent #6362091).

With respect to **claims 1, 14, 15, and 29**, Bao teaches a semiconductor substrate (Fig. 5, 10), a first copper layer formed overlying the semiconductor

substrate (Fig. 5, 12), an etch stop layer formed overlying the first metal layer and the semiconductor substrate (Fig. 5, 14a), a dielectric layer formed overlying the etch stop layer (Fig. 5, 16a), a second copper layer penetrating the dielectric layer and the etch stop layer and electrically connected to the first metal layer (Fig. 5, 32), wherein the etch stop layer has a dielectric constant smaller than 3.5 (Col 6 Ln 34-38, physical property of carbon doped silicon nitride and carbon doped silicon oxide), and wherein the dielectric layer has a dielectric constant smaller than 3.0 (Col 8 Ln 38-42). Bao does not teach that the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer. Andideh teaches that a layer of a material with high compressive stress can be formed adjacent to other layers of a material having high tensile stress (Col 4 Ln 3-30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the tensile stress of the dielectric layer be approximate to the compressive stress of the etch stop layer based on the teachings of Andideh in order to minimize the effect of the tensile stress and improve the crack resistance of the dielectric layers (Col 2 Ln 4-8).

With respect to **claim 6**, Bao teaches that both the first metal layer (Col 5 Ln 62) and the second metal layer (Col 11 Ln 52) are copper layers.

With respect to **claims 21 and 34**, Bao teaches an etch stop layer is a composite film comprising a first etch stop layer and a second etch stop layer, in which the first etch stop layer is formed overlying the second etch stop layer.

With respect to **claims 11, 26, and 38**, Bao teaches that the etch stop layer is a SiCO-based composite deposition (Col 6 Ln 36-37).

With respect to **claim 13, 28, and 40**, Bao teaches that each of the first etch stop layer and the second etch stop layer is SiCN, SiCO, SiN, SiON, SiC, or a combination thereof (Col 6 Ln 34-38).

With respect to **claims 20 and 33**, Bao teaches that the second copper layer is a copper dual damascene structure (Fig. 5, 32).

Claims 2, 16, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao and Andideh, in view of Campana et al (U.S. Patent #6537733).

With respect to **claims 2, 16, and 30**, Bao does not that the etch stop layer has a compressive stress of 0-1x10^9 dynes/cm^2. Campana teaches a silicon carbide layer having a compressive stress of 5x10^8 dynes/cm^2 (Col 6 Ln 28). It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the etch stop layer of Bao with a compressive stress of 0-1x10^9 dynes/cm^2 as taught by Campana in order to make the layer resistive to peeling and cracking.

Claims 4, 18, and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao and Andideh, in view of Wong (U.S. PG Pub #20030224593).

With respect to **claim 4, 18, and 31**, Bao does not teach a dielectric layer with a film hardness greater than 0.2 GPa and an elastic modulus greater than 5

GPa. Wong teaches a dielectric layer with a film hardness greater than 0.2 GPa (Claim 19) and an elastic modulus greater than 5 GPa (Claim 25). It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide a dielectric with the properties taught by Wong in order to make the device resistant to stresses.

Claims 5, 19, and 32 rejected under 35 U.S.C. 103(a) as being unpatentable over Bao and Chow, in view of Lu et al (U.S. PG Pub #20020100693).

With respect to **claims 5, 19, and 32**, Bao teaches that the etch stop layer is a SiOC layer (Col 6 Ln 36-37), but does not teach that the dielectric layer is a porous organo-silicate glass layer. Lu teaches a dielectric layer that is formed from OSG (Paragraph 13).). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use OSG to form the dielectric layer as taught by Lu because the material has a low dielectric constant.

Claims 8, 9,12, 22-24, 27, 35, and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao and Andideh, in view of Li et al (U.S. Patent #6753260).

With respect to **claim 12, 27, and 39**, Bao and Andideh teach all of the limitations of claim 11, 26, and 38, but do not teach that a first etch stop layer is a SiC film and the second etch stop layer is a SiO film. Li teaches a first etch stop layer is a SiC film (Fig. 1, 16 and Col 2 Ln 57), and a second etch stop layer is a SiO film (Fig. 1, 18 and Col 2 Ln 62). It would have been obvious to one of

ordinary skill in the art at the time the invention was made to make the etch stop layer of Bao with the first layer being a SiC film and the second layer being a SiO film as taught by Li in order to enhance the moisture resistance and etching selectivity of the etch top layer.

With respect to **claims 8, 9, 22-24, 35, and 36**, Bao and Andideh teach all of the limitations of claims 7, 21, and 34 respectively, but do not teach a first etching selectivity S1 of the first etch stop layer to the dielectric layer, and a second etching selectivity S2 of the second etch stop layer to the dielectric layer satisfy the formula: $S1 \neq S2$, or that S1 and S2 satisfy the formula: $0<S1<S2$. Since Li teaches the limitations of claim 12 as shown above it is assumed that the materials described will meet the limitations of claims 8 and 9. It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the etch stop layer of Bao with materials wherein $0<S1<S2$ as taught by Li in order to improve the fabrication process of the device.

Claims 10, 25, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao and Andideh, in view of Kloster et al (U.S. PG Pub #20020140103).

With respect to **claim 10, 25, and 37**, Bao does not teach a first thickness T1 of the first etch stop layer and a second thickness T2 of the second etch stop layer satisfy the formula: $T2 < (T1+ T2) /3$. An equivalent formula for this limitation is $T2 \leq (1/2)T1$. Kloster teaches a composite etch stop layer where the

bottom layer (Fig. 1, 16) is less than half the thickness of the top layer (Fig. 1, 18 and Paragraph 39). It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the composite etch stop layer of Bao with $T2 < (T1+ T2)/3$ as taught by Kloster in order to create an optimal arrangement for etching.

Claims 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, in view of Andideh, further in view of Chen et al (U.S. Patent #6873057).

With respect to **claim 42**, Bao teaches a semiconductor substrate (Fig. 5, 10), a first copper layer formed overlying the semiconductor substrate (Fig. 5, 12), a composite film etch stop layer comprising a first etch stop layer and a second etch stop layer, in which the first etch stop layer is formed overlying the second etch stop layer (Fig. 5, 14), a dielectric layer formed overlying the etch stop layer (Fig. 5, 16a), a second copper layer penetrating the dielectric layer and the etch stop layer and electrically connected to the first metal layer (Fig. 5, 32), wherein the etch stop layer has a dielectric constant smaller than 3.5 (Col 6 Ln 34-38, physical property of carbon doped silicon nitride and carbon doped silicon oxide), and wherein the dielectric layer has a dielectric constant smaller than 3.0 (Col 8 Ln 38-42). Bao does not teach that the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer. Andideh teaches that a layer of a material with high compressive stress can be formed adjacent to other layers of a material having high tensile stress (Col 4 Ln 3-30). It would

have been obvious to one of ordinary skill in the art at the time the invention was made to have the tensile stress of the dielectric layer be approximate to the compressive stress of the etch stop layer based on the teachings of Andideh in order to minimize the effect of the tensile stress and improve the crack resistance of the dielectric layers (Col 2 Ln 4-8). Furthermore, Bao teaches that the first etch stop layer is a SiCO film (Col 4 Ln 31), but does not teach that the second etch stop layer is a SiN film. Chen teaches a composite etch stop layer having a first layer of oxygen doped silicon carbide and a second layer of SiN (Col 3 Ln 53-58). It would have been obvious to one of ordinary skill in the art at time the invention was made to provide a composite etch stop layer of SiCO and SiN as taught by Chen in order to prevent cracking the device.

Claims 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, in view of Andideh, further in view of Guo et al (U.S. PG Pub #2003/0134521).

With respect to **claim 42**, Bao teaches a semiconductor substrate (Fig. 5, 10), a first copper layer formed overlying the semiconductor substrate (Fig. 5, 12), a composite film etch stop layer comprising a first etch stop layer and a second etch stop layer, in which the first etch stop layer is formed overlying the second etch stop layer (Fig. 5, 14), a dielectric layer formed overlying the etch stop layer (Fig. 5, 16a), a second copper layer penetrating the dielectric layer and the etch stop layer and electrically connected to the first metal layer (Fig. 5, 32), wherein the etch stop layer has a dielectric constant smaller than 3.5 (Col 6 Ln

34-38, physical property of carbon doped silicon nitride and carbon doped silicon oxide), and wherein the dielectric layer has a dielectric constant smaller than 3.0 (Col 8 Ln 38-42). Bao does not teach that the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer. Andideh teaches that a layer of a material with high compressive stress can be formed adjacent to other layers of a material having high tensile stress (Col 4 Ln 3-30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the tensile stress of the dielectric layer be approximate to the compressive stress of the etch stop layer based on the teachings of Andideh in order to minimize the effect of the tensile stress and improve the crack resistance of the dielectric layers (Col 2 Ln 4-8). Furthermore, Bao teaches that the first etch stop layer is a SiCO film (Col 4 Ln 31), but does not teach that the second etch stop layer is a SiCO film. Guo teaches a composite etch stop layer of

Claim 43 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, Andideh, and Chen, in view of Campana et al (U.S. Patent #6537733).

With respect to **claim 43**, Bao does not that the etch stop layer has a compressive stress of 0-1x10^9 dynes/cm^2. Campana teaches a silicon carbide layer having a compressive stress of 5x10^8 dynes/cm^2 (Col 6 Ln 28). It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the etch stop layer of Bao with a compressive stress of 0-1x10^9

dynes/cm^2 as taught by Campana in order to make the layer resistive to peeling and cracking.

Claims 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, Andideh, and Chen, in view of Wong (U.S. PG Pub #20030224593).

With respect to **claim 44**, Bao does not teach a dielectric layer with a film hardness greater than 0.2 GPa and an elastic modulus greater than 5 GPa. Wong teaches a dielectric layer with a film hardness greater than 0.2 GPa (Claim 19) and an elastic modulus greater than 5 GPa (Claim 25). It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide a dielectric with the properties taught by Wong in order to make the device resistant to stresses.

Claims 45 and 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, Andideh, and Chen, in view of Li et al (U.S. Patent #6753260).

With respect to **claims 45 and 46**, Bao does not teach a first etching selectivity S1 of the first etch stop layer to the dielectric layer, and a second etching selectivity S2 of the second etch stop layer to the dielectric layer satisfy the formula: $S1 \neq S2$, or that S1 and S2 satisfy the formula: $0<S1<S2$. Since Li teaches the limitations of claim 12 as shown above it is assumed that the materials described will meet the limitations of claims 8 and 9. It would have been obvious to one of ordinary skill in the art at the time the invention was made

to make the etch stop layer of Bao with materials wherein 0<S1<S2 as taught by Li in order to improve the fabrication process of the device.

Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bao, Andideh, and Chen, in view of Kloster et al (U.S. PG Pub #20020140103).

With respect to **claim 47**, Bao does not teach a first thickness T1 of the first etch stop layer and a second thickness T2 of the second etch stop layer satisfy the formula: $T2 < (T1+ T2)/3$. An equivalent formula for this limitation is $T2 \leq (1/2)T1$. Kloster teaches a composite etch stop layer where the bottom layer (Fig. 1, 16) is less than half the thickness of the top layer (Fig. 1, 18 and Paragraph 39). It would have been obvious to one of ordinary skill in the art at the time the invention was made to make the composite etch stop layer of Bao with $T2 < (T1+ T2)/3$ as taught by Kloster in order to create an optimal arrangement for etching.

Allowable Subject Matter

Claims 48-52 are allowed.

Claim 41 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben P. Sandvik whose telephone number is (571) 272-8446. The examiner can normally be reached on Mon-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

bps

EVAN PERT
PRIMARY EXAMINER